Radarthrs tuning for DFS radar detection

Application Note

Revision 4.0
July 2012

1. NVRAM

The "wl radarthrs" settings have been included in nvram as the most appropriate threshold settings will be product specific (i.e. dependant upon Rx path loss and antenna gain).

No other radar detection algorithm tuning, i.e. radarargs, should be required to ensure regulatory compliance.

Broadcom strongly advise against changing radarargs parameters for compliance testing as this could have adverse affects on the detection and false detection prevention capabilities.

2. Driver

In order to meet radar detection criteria and protect against false detection it is advised that recent driver is used. This should include all the fixes required for worldwide regulatory compliance in FCC/Japan/EU/Korea and Brazil and latest algorithm for prevention of false detections.

3. Notes

- The worst case detection in terms of threshold levels is defined by short pulse radars at the channel center frequency (where dc filtering occurs).
- Tune this center frequency to a threshold of either -62dBm (<200mW equipment) or -64dBm (>200mW equipment) based upon 0dBi antenna dependant upon the power level that you are testing.
- The antenna gain should be factored into the threshold tuned i.e. a product of with an antenna gain of 4dBi and set to transmit at <200mW should be tuned to -58dBm (-62dBm +4)for testing/algorithm tuning purposes.
- All tuning is to be performed using no traffic conditions. Addition of traffic is required for formal testing however it is expected that if we see 100% detection without traffic the product will comply when correct traffic conditions are applied.
- As well as tuning the detection threshold and having the correct driver/algorithm it is important that you use appropriate traffic conditions for test. The traffic conditions are specific to the country under test. See "DFS Troubleshooting" document for further information.
- The radar detection threshold levels for 20/40MHz signaling for low (5250-5350MHz) and high (5470-5725MHz) DFS bands are tuned using the following command:
  "wl radarthrs thresh0_20_lo thresh1_20_lo thresh0_40_low thresh1_40_lo thresh0_20_hi thresh1_20_hi thresh0_high 40_Hi thresh1_40_hi"
  Example:
  wl radarthrs 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 (older radios)
  wl radarthrs 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 (newer radios)
  {Note: Each hex increments is equivalent to a 0.25dB step}

- The radar detection threshold levels for 20/40/80MHz signaling for low (5250-5350MHz) and high (5470-5725MHz) DFS bands are tuned using the following command:

  order as thresh0_20_lo, thresh1_20_lo, thresh0_40_lo, thresh1_40_lo
  thresh0_80_lo, thresh1_80_lo, thresh0_20_hi, thresh1_20_hi
  thresh0_40_hi, thresh1_40_hi, thresh0_80_hi, thresh1_80_hi

  Example:

  wl radarthrs 0x6c4 0x30 0x6c8 0x30 0x6c6 0x30 0x6c0 0x30 0x6c0 0x30 0x6c0 0x30

- The thresh0 setting determines the level of detection. We have seen through investigation that the algorithm performs best when the thresh1 has the following offsets from thresh0:

  20/40/80MHz: thresh0 = x, thresh1 = x + 12dB (e.g. 0x6d8 – 0x6a8 in 0.25dB steps).

  The 12dB has been fixed as 0x30 for newer radios as above so you only need to tune the thresh0 setting.

- When entered these should align with the thresh0,1 values in "wl radarargs" commands. The phyreg 0xf3 (0xf255- 11ac radios) and phyreg 0xf4(0xf256 -11ac radios) should also reflect the same thresh0 and thresh1 settings respectively.

- You can set these values in nvram using the following commands:

  nvram set wl_radarthrs="0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8"
  nvram commit

- The FCC allow a +1dB increase to the radar power level for test purposes. The following tuning procedure is a generic method to tune the equipment suitable for compliance worldwide. It therefore does not include the 1dB easement which is not applicable in other countries such as EU and Japan.

- If performing radiated measurements maximize the directional gain of the lowest peak gain antenna.

- Testing can be performed radiated or conducted however it should be noted that the FCC perform repeat testing radiated at FCC OET lab. It is therefore advised that a minimum spot check is performed on the radar detection criteria in a radiated manner prior to shipping samples to the FCC.

4. Antenna/BW Maximization (Radiated testing)

The antenna can be maximized using the following commands. This must be done in addition to worst case antenna/product orientation and nrate settings.

wl txant {To force transmit antenna for SISO transmissions}
wl nphy_antsel {To force transmit antenna for MIMO transmissions}

wl txant
This command can be used to force the transmit power to a particular antenna for SISO (i.e. # transmit chains =1) modes of operation e.g. legacy 11b mode.
wl txant 0   {Forces main antenna}
wl txant 1   {Forces Aux antenna}
wl txant 2   {Forces middle antenna where supported}.
wl nphy_antsel
This command is required where the device incorporates more than 2 antennas, for example a 3 antenna device which uses 2 of 3 antenna diversity. In this case

the MIMO (i.e. # transmit chains=2) power can be forced to any pair of antennas for testing purposes as per the following examples:

wl nphy_antsel 0x01   {Forces the 2 transmit chain power from Main/Aux}
wl nphy_antsel 0x02   {Forces the 2 transmit chain power from Main/Middle}
wl nphy_antsel 0x21   {Forces the 2 transmit chain power from Middle/Aux}

The 40/80MHz BW setting can be forced during test in the GUI or using the "mimo_bw_cap" and "mimo_txbw" commands.

5. Radarthrs tuning procedure for worldwide compliance

The procedure to tune power is as below.
- Disable any traffic
- Set radar generator to the EU reference radar/ FCC Type 1 (pw=1us, 700PRF, 18 pulses). NOTE: We ONLY use this radar for tuning. Do not use variable, hopping or long pulse radars.
- Disable channel switch on EUT (wl dfs_ism_monitor 1)
- Enable DFS message level indication (dmesg –n -8, wl msglevel dfs).

20MHz Low band Tuning.

CH52 Tuning
- Set to center frequency of CH52 (5260MHz).
- Set radar threshold for test on channel center frequency e.g.
    For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain

- Set the thresh0/1 using the radarthrs command e.g. for 20MHz channel 52 in the low band tune the highlighted example values below:
  wl radarthrs 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 (older radios)
  wl radarthrs 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 (newer radios)
  wl radarthrs 0x6a80x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8
  0x30 (11ac radios)

- Set wl radarthrs and ensure that they are correctly setting in the driver by reading back *wl radarargs* command. Note: wl phyreg 0xf3/f255 (thresh0) and wl phyreg 0xf4/f256 (thresh1) should also set to the same.
- By increasing/decreasing the thresh0/1 settings in 1dB steps tune to the least sensitive level where 100% detection with no traffic is seen on 30 trials of the EU reference/FCC Type 1 radar detailed above. Record this thresh0 as "T" (e.g. 0x69c). For older products set thresh1 to a 12dB offset (e.g. 0x6cc). Please use the radar detection tuning proforma provided for this, see also Appendix A.
- To allow for tolerances in lab equipment and radar types increase the sensitivity 3dB from "T" to a setting of "T" + 3dB (e.g. 0x690).

CH64 Tuning
- Set to signal generator and EUT to center frequency of CH64 (5320MHz).
- Set radar threshold for test on channel center frequency e.g.
    For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain

- Check that the detection is still 30/30 for both the "T" and "T"+3dB settings. If 30/30 is seen then this is the final value of "T".
- If not re-tune to a new setting of "T" where 30/30 detections is seen on CH64. Record this new value of "T".

- The Final setting to go in the driver for the 20MHz, Low band (5250-5350MHz band) is the final value of tuned "T" + 3dB. This will ensure optimum detection across all 20MHz channels in the band.
- NOTE: "T" + 3dB is level at which 100% detection is first achieved with a 3dB tolerance to increase sensitivity. A tolerance of <3dB may be too insensitive especially on the worst case radar with traffic (EU Type 2). DO NOT make this value over sensitive. A value >3dB may introduce false detections or could make the FIFO so sensitive that the noise it sees inhibits detection.

20MHz High band Tuning.

CH100 Tuning
- Set to center frequency of CH100 (5500MHz).
- Set radar threshold for test on channel center frequency e.g.
  For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain
  For equipment Tx @ >200mW set test threshold to -64dBm + antenna gain

- Set the thresh0/1 using the radarthrs command e.g. for 20MHz channel 100 in the low band tune the highlighted example values below:
  wl radarthrs 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 (older radios)
  wl radarthrs 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 (newer radios)
  wl radarthrs 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8
  0x30 (11ac radios)

- Set wl radarthrs and ensure that they are correctly setting in the driver by reading back *wl radarargs* command. Note: wl phyreg 0xf3/255 (thresh0) and wl phyreg 0xf4/255 (thresh1) should also set to the same.
- By increasing/decreasing the thresh0/1 settings in 1dB steps tune to the least sensitive level where 100% detection with no traffic is seen on 30 trials of the EU reference/FCC Type 1 radar detailed above. Record this thresh0 as "T" (e.g. 0x69c). For older products set thresh1 to a 12dB offset (e.g. 0x6cc).Please use the radar detection tuning proforma provided for this, see Appendix A.
- To allow for tolerances in lab equipment and radar types increase the sensitivity 3dB from "T" to a setting of "T" + 3dB (e.g. 0x6c0).

CH140 Tuning Or CH144 if Supported
- Set to signal generator and EUT to center frequency of CH140 (5700MHz)/ CH144(5720MHz).
- Set radar threshold for test on channel center frequency e.g.
  For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain
  For equipment Tx @ >200mW set test threshold to -64dBm + antenna gain

- Check that the detection is still 30/30 for both the "T" and "T"+3dB settings. If 30/30 is seen then this is the final value of T.
- If not re-tune to a new setting of "T" where 30/30 detections is seen on CH140/CH144. Record this new value of "T".

- The Final setting to go in the driver for the 20MHz, High band (5470-5725MHz band) is the final value of tuned "T" + 3dB. This will ensure optimum detection across all channels in the band.
- NOTE: "T" + 3dB is level at which 100% detection is first achieved with a 3dB tolerance to increase sensitivity. A tolerance of <3dB may be too insensitive especially on the worst case radar with traffic (EU Type 2). DO NOT make this value over sensitive. A value >3dB may introduce false detections or could make the FIFO so sensitive that the noise it sees inhibits detection.

40MHz Low band Tuning.
Note: On 11ac drivers the "radarargs40" command is obselete. Use "radarargs".

CH54 Tuning
- Set to center frequency of CH54 (5270MHz).
- Set radar threshold for test on channel center frequency e.g.
  For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain

- Set the thresh0/1 using the radarthrs command e.g. for 40MHz channel 54 in the low band tune the highlighted example values below:
  wl radarthrs 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 (older radios)
  wl radarthrs 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 (newer radios)
  wl radarthrs 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8
  0x30 (11ac radios)

- Set wl radarthrs and ensure that they are correctly setting in the driver by reading back *wl radarargs(40)* command. Note: wl phyreg 0xf3/255 (thresh0) and wl phyreg 0xf4/256 (thresh1) should also set to the same.
- By increasing/decreasing the thresh0/1 settings in 1dB steps tune to the least sensitive level where 100% detection with no traffic is seen on 30 trials of the EU reference/FCC Type 1 radar detailed above. Record this thresh0 as "T" (e.g. 0x69c). For older products set thresh1 to a 12dB offset (e.g. 0x6cc). Please use the radar detection tuning proforma provided for this, see Appendix A.
- To allow for tolerances in lab equipment and radar types increase the sensitivity 3dB from "T" to a setting of "T" + 3dB (e.g. 0x6c0).

CH62 Tuning
- Set to signal generator and EUT to center frequency of CH62 (5310MHz).
- Set radar threshold for test on channel center frequency e.g.
  For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain

- Check that the detection is still 30/30 for both the "T" and "T"+3dB settings. If 30/30 is seen then this is the final value of T.
- If not re-tune to a new setting of "T" where 30/30 detections is seen on CH62. Record this new value of "T".
- The Final setting to go in the driver for the 40MHz, Low band (5250-5350MHz band) is the final value of tuned "T" + 3dB. This will ensure optimum detection across all 40MHz channels in the band.

- NOTE: "T" + 3dB is level at which 100% detection is first achieved with a 3dB tolerance to increase sensitivity. A tolerance of <3dB may be too insensitive especially on the worst case radar with traffic (EU Type 2). DO NOT make this value over sensitive. A value >3dB may introduce false detections or could make the FIFO so sensitive that the noise it sees inhibits detection.

40MHz High band Tuning.

CH102 Tuning
- Set to center frequency of CH102 (5510MHz).
- Set radar threshold for test on channel center frequency e.g.
    For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain
    For equipment Tx @ >200mW set test threshold to -64dBm + antenna gain

- Set the thresh0/1 using the radarthrs command e.g. for 40MHz channel 102 in the low band tune the highlighted example values below:
  wl radarthrs 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 0x6a8 0x6d8 (older radios)
  wl radarthrs 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 (newer radios)
  wl radarthrs 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 (11ac radios)

- Set wl radarthrs and ensure that they are correctly setting in the driver by reading back *wl radarargs(40)* command. Note: wl phyreg 0xf3/f255 (thresh0) and wl phyreg 0xf4/f256 (thresh1) should also set to the same.
- By increasing/decreasing the thresh0/1 settings in 1dB steps tune to the least sensitive level where 100% detection with no traffic is seen on 30 trials of the EU reference/FCC Type 1 radar detailed above. Record this thresh0 as "T" (e.g. 0x69c). For older products set thresh1 to a 12dB offset (e.g. 0x6cc). Please use the radar detection tuning proforma provided for this, see Appendix A.
- To allow for tolerances in lab equipment and radar types increase the sensitivity 3dB from "T" to a setting of "T" + 3dB (e.g. 0x6c0).

CH134 Tuning or Ch142 if supported.
- Set to signal generator and EUT to center frequency of CH134 (5670MHz) or 142(5710MHz).
- Set radar threshold for test on channel center frequency e.g.
    For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain
    For equipment Tx @ >200mW set test threshold to -64dBm + antenna gain

- Check that the detection is still 30/30 for both the "T" and "T"+3dB settings. If 30/30 is seen then this is the final value of T.
- If not re-tune to a new setting of "T" where 30/30 detections is seen on CH134. Record this new value of "T".
- The Final setting to go in the driver for the 40MHz, High band (5470-5725MHz band) is the final value of tuned "T" + 3dB. This will ensure optimum detection across all channels in the band.

- NOTE: "T" + 3dB is level at which 100% detection is first achieved with a 3dB tolerance to increase sensitivity. A tolerance of <3dB may be too insensitive especially on the worst case radar with traffic (EU Type 2). DO NOT make this value over sensitive. A value >3dB may introduce false detections or could make the FIFO so sensitive that the noise it sees inhibits detection.

80MHz Low band Tuning.

CH58 Tuning
- Set to center frequency of CH58 (5290MHz).
- Set radar threshold for test on channel center frequency e.g.
    For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain

- Set the thresh0/1 using the radarthrs command e.g. for 80MHz channel 58 in the low band tune the highlighted example values below:
    wl radarthrs 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 (11ac radios)

- Set wl radarthrs and ensure that they are correctly setting in the driver by reading back *wl radarargs* command. Note: wl phyreg 0xf255 (thresh0) and wl phyreg 0xf256 (thresh1) should also set to the same.
- By increasing/decreasing the thresh0/1 settings in 1dB steps tune to the least sensitive level where 100% detection with no traffic is seen on 30 trials of the EU reference/FCC Type 1 radar detailed above. Record this thresh0 as "T" (e.g. 0x69c). Please use the radar detection tuning proforma provided for this, see Appendix A.
- To allow for tolerances in lab equipment and radar types increase the sensitivity 3dB from "T" to a setting of "T" + 3dB (e.g. 0x6c0).

80MHz High band Tuning.

CH106 Tuning
- Set to center frequency of CH106 (5530MHz).
- Set radar threshold for test on channel center frequency e.g.
    For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain
    For equipment Tx @ >200mW set test threshold to -64dBm + antenna gain

- Set the thresh0/1 using the radarthrs command e.g. for 80MHz channel 106 in the low band tune the highlighted example values below:
    wl radarthrs 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 0x6a8 0x30 (11ac radios)

- Set wl radarthrs and ensure that they are correctly setting in the driver by reading back *wl radarargs* command. Note: wl phyreg 0xf255 (thresh0) and wl phyreg 0xf256 (thresh1) should also set to the same.
- By increasing/decreasing the thresh0/1 settings in 1dB steps tune to the least sensitive level where 100% detection with no traffic is seen on 30 trials of the EU

reference/FCC Type 1 radar detailed above. Record this thresh0 as "T" (e.g. 0x69c). For older products set thresh1 to a 12dB offset (e.g. 0x6cc). Please use the radar detection tuning proforma provided for this, see Appendix A.

- To allow for tolerances in lab equipment and radar types increase the sensitivity 3dB from "T" to a setting of "T" + 3dB (e.g. 0x6c0).

CH138 Tuning
- Set to signal generator and EUT to center frequency of CH138 (5690MHz).
- Set radar threshold for test on channel center frequency e.g.
    For equipment Tx @ <200mW set test threshold to -62dBm + antenna gain
    For equipment Tx @ >200mW set test threshold to -64dBm + antenna gain

- Check that the detection is still 30/30 for both the "T" and "T"+3dB settings. If 30/30 is seen then this is the final value of T.
- If not re-tune to a new setting of "T" where 30/30 detections is seen on CH138. Record this new value of "T".
- The Final setting to go in the driver for the 80MHz, High band (5470-5725MHz band) is the final value of tuned "T" + 3dB. This will ensure optimum detection across all channels in the band.
- NOTE: "T" + 3dB is level at which 100% detection is first achieved with a 3dB tolerance to increase sensitivity. A tolerance of <3dB may be too insensitive especially on the worst case radar with traffic (EU Type 2). DO NOT make this value over sensitive. A value >3dB may introduce false detections or could make the FIFO so sensitive that the noise it sees inhibits detection.

APPENDIX A: Radar Detection Threshold Tuning Proforma

Product:

Antenna
gain(dBi):

Power ref:

Driver:

20MHz Tuning (5250-5350MHz Band)

Channel	Threshold setting	Detection /30 trials	Channel	Threshold setting	Detection /30 trials
52			64		

40MHz Tuning (5250-5350MHz Band)

Channel	Threshold setting	Detection /30 trials	Channel	Threshold setting	Detection /30 trials
54			62		

80MHz Tuning (5250-5350MHz Band)

Channel	Threshold setting	Detection /30 trials	Channel	Threshold setting	Detection /30 trials
58			NA		

Notes:

Tune on center frequency, Using FCC Type 1

Perform tuning measurements with no traffic

The final threshold setting to be used should be backed off 3dB from the level at which 100% detection "T" is seen without traffic (i.e."T+3dB)

Tune Channels CH52 to CH64 to -62dBm. Tune Channels CH100 to CH140 to -62dBm or -64dBm

Product:

Antenna
 gain(dBi):

Power ref:

Driver:

20MHz Tuning (5470-5725MHz Band)

Channel	Threshold setting	Detection /30 trials	Channel	Threshold setting	Detection /30 trials
100			140/ 144		

40MHz Tuning (5470-5725MHz Band)

Channel	Threshold setting	Detection /30 trials	Channel	Threshold setting	Detection /30 trials
102			134/ 142		

80MHz Tuning (5470-5725MHz Band)

Channel	Threshold setting	Detection /30 trials	Channel	Threshold setting	Detection /30 trials
106			138		

Notes:

Tune on center frequency, Using FCC Type 1

Perform tuning measurements with no traffic

The final threshold setting to be used should be backed off 3dB from the level at which 100%

Detection "T" is seen without traffic (i.e. T"+3dB)
Tune Channels CH52 to CH64 to -62dBm. Tune Channels CH100 to CH140 to -62dBm or -64dBm